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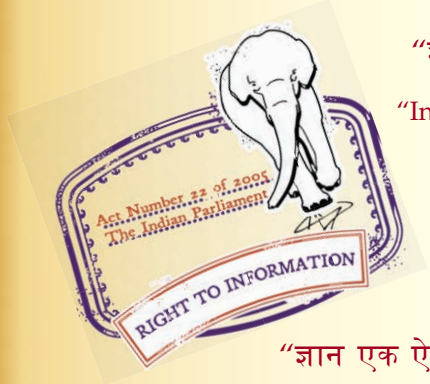
IS 4461 (1998): Code of practice for joints in surface hydro-electric power stations [WRD 15: Hydroelectric Power House Structures]



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"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
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"Knowledge is such a treasure which cannot be stolen"

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IS 4461 : 1998
(Reaffirmed 2003)

भारतीय मानक

सतह पनबिजली पावर केन्द्रों में जोड़ों की रीति संहिता

(दूसरा पुनरीक्षण)

Indian Standard

CODE OF PRACTICE FOR JOINTS IN SURFACE HYDROELECTRIC POWER STATIONS

(Second Revision)

ICS 27.140

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

December 1998

Price Group 6

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Hydroelectric Power Structures Sectional Committee had been approved by the River Valley Division Council.

In designing large concrete structures of surface hydroelectric power stations, consideration is to be given to appropriate positioning of joints in the concrete. Proper location of joints facilitates construction work and prevents unsightly or destructive cracking of the structure. Joints in the power station structures are also required to sectionalise different parts of the same structure which, while in service may harmfully transmit to each other vibratory stresses or thrusts, if not separated, or may be subjected to differential settlements. The arrangement of main units in hydroelectric power stations necessitates the design of long, narrow buildings which require joints not only to prevent objectionable cracking, but also to allow for expansion and to ensure against misalignment of machinery that would otherwise result from structural distortion.

This standard was first published in 1967 and subsequently revised in 1979. The revision of this standard has been taken up in the light of experience gained during the use of this standard. The major changes in this revision are inclusion of polyvinyl chloride water stops polysulphide based sealants for expansion joints. The other changes in this revision are additions regarding different types of water stops and the selection of their type and size.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

CODE OF PRACTICE FOR JOINTS IN SURFACE HYDROELECTRIC POWER STATIONS

(Second Revision)

1 SCOPE

This standard covers the location, design, construction and waterproofing arrangements of all types of joints to be provided in surface hydroelectric power stations.

2 REFERENCES

The Indian Standards listed below are necessary adjuncts to this standard :

IS No.	*Title*
73 : 1992	Specification for paving bitumen (*second revision*)
216 : 1961	Specification for coal tar pitch (*first revision*)
702 : 1988	Specification for industrial bitumen (*second revision*)
1838 (Part 1) : 1983	Specification for preformed fillers for expansion joints in concrete pavements and structures (non extruding and resilient type): Part 1 Bitumen impregnated fibre (*first revision*)
3709 : 1966	Mastic cement for bedding of metal windows
4326 : 1993	Code of practice for earthquake resistant design and construction of buildings (*second revision*)
4410 (Part 10) : 1988	Glossary of terms relating to river valley projects: Part 10 Hydroelectric power station including water conductor system (*first revision*)
12118	Specification for two parts polysulphide based sealants:
(Part 1) : 1987	Part 1 General requirements
(Part 2) : 1987	Part 2 Method of tests
12200 : 1987	Provision of water stops at transverse and contraction joints in masonry and concrete dams
13143 : 1991	Specification for sealing joints in concrete lining on canals — Sealing compound

3 TERMINOLOGY

3.0 For the purpose of this standard, the following definitions shall apply [*see also* IS 4410 (Part 10)].

3.1 Sub-structure

The portion of structure of power station extending from the bottom of the draft type bottom slab up to the top of draft tube top slab.

3.2 Intermediate Structure

The portion of structure of power station extending from the top of draft tube top slab to the generator floor consisting of speed ring and its support, the generator supporting barrel and the concrete around the spiral casing and various floors.

3.3 Superstructure

The portion of structure of power station extending from generator floor right up to the top roof including gantry columns, walls, etc.

4 INFORMATION REQUIRED

For planning a satisfactory arrangement of joints and their waterproofing arrangements the following data shall normally be available:

a) Plans at different levels and sections of the power stations and adjacent structures, if any, giving complete information about the disposition and utilisation of all the floor spaces;
b) Layout plan of the power station area with levels and contours;
c) Water levels given below shall be known:
   i) Maximum tailwater level or highest downstream flood level;
   ii) Normal tailwater level;
   iii) Ground water level; and
   iv) Upstream water level, if applicable;
d) Available construction equipment and sequence of construction and erection of machinery;
e) Borehole logs of power house pit showing strata to be encountered from surface to foundation level;

f) Heat of hydration of cement to be used;
g) Maximum and minimum daily temperature at construction site;
h) Temperature range in period during which concrete is proposed to be poured;
j) Temperature range of the curing water;
k) Quantity of concrete that may conveniently be poured at a stretch; and
m) Annual rainfall and its maximum intensity.

5 TYPES OF JOINTS

5.1 From the point of view of utility the joints as provided in power stations may be classified as given in **5.1.1** to **5.1.6**.

5.1.1 *Construction Joints*

Construction joints are produced by placing fresh concrete against surface of hardened concrete. Construction joints are generally but not necessarily, vertical or horizontal. In either case, the reinforcement steel shall be continued across the joint and care shall be taken to obtain good bond between the two placements of concrete. Shear keys may also be provided in cases where heavy shear caused by lateral loads is to be resisted by the joint (*see* Fig. 1). This type of joint, obviously does not introduce any structural discontinuity. The construction joints are necessary to suit:

a) the construction sequence depending upon the availability of hydromechanical and hydroelectrical equipment;
b) the available construction equipment;
c) to minimise the effect of restraint and temperature rise of the concrete after placement which, in turn, reduces the amounts of shrinkage reinforcement; and
d) to maintain structural continuity reinforcement pattern shall not be disturbed. Special emphasis shall be given by the designer, while preparing detailed drawing of such joints.

5.1.2 *Contraction Joints*

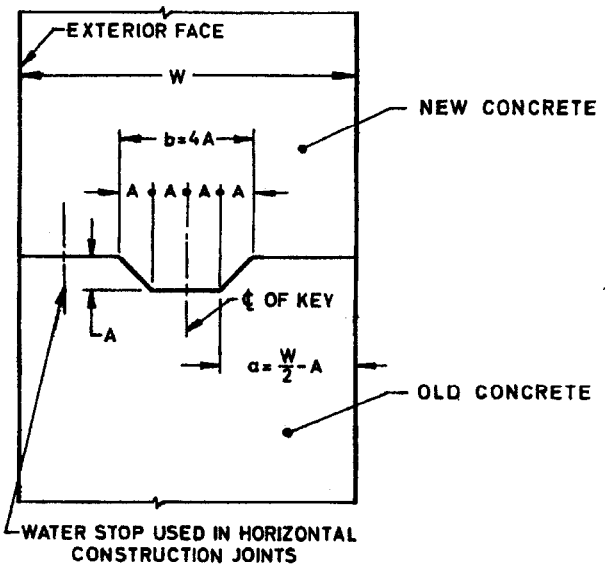
These are provided to eliminate tensile stresses due to shrinkage and are commonly used where temperature variations are small and where there is no likelihood of expansion such as spaces below water and earth levels and unexposed to atmosphere. At contraction joints the reinforcement is discontinued and bond is not allowed to develop between the joint faces thereby introducing a structural discontinuity. A contraction joint also serves as a construction joint so far as break in the pouring of concrete is concerned.

5.1.3 *Expansion Joints*

These are provided either to completely eliminate or to significantly reduce compressive stresses in concrete that would otherwise result from thermal expansion and might crush buckle or crack parts of the structure. Expansion joints serve the purpose of contraction and also construction joints.

5.1.4 *Control Joints*

These are provided at places where the cracking is inevitable. Planes of weaknesses are introduced by the provision of control joints so that the cracking takes



NOTE

1 Take $A = \frac{W}{100}$ for equal shear strength on portions *a* and *b*. Take $a = b$ for average wall thickness.

2 For walls more than 2-metre thick, provide one or more keys.

FIG. 1 TYPICAL DETAILS OF SHEAR KEY

place along these joints instead of allowing it to develop in a haphazard manner.

5.1.5 *Separation Joints*

The places where the expansion of the structure is not expected but these are required to be kept structurally separate so that stresses, vibrations, etc, are not transferred from one structure to the adjoining structure, a separation joint shall be provided. Like expansion joint, a gap is provided in separation joint also, but this is not expected to be used up by the expansion of members.

5.1.6 *Settlement Joints*

Structures which are likely to settle with respect to its adjacent structures shall be separated by a settlement joint so that the adverse effects of differential settlement are obviated. It is like an expansion joint but with a different sealing arrangement.

6 LOCATION OF JOINTS

6.1 General

Joints in power stations are generally provided between different units, sections of a building having wide variation in cross sections; at junctions between portions built on different foundations; at angles between large portions of buildings occurring in L-T and U-shape structures; where walls are weakened by openings; and where it is necessary to interrupt the placement of concrete either from the considerations of construction facility or excessive temperature stresses. Selection or exact position of joint is governed by structural and constructional requirements.

6.2 Location of Joints in Sub-structure

6.2.1 *Construction Joints*

These are governed by the extent to which continuous concreting may be done keeping in view the sequence of construction and that the temperature stresses are kept under control. Accordingly a lift shall normally be kept as 1.5 m and length of individual sections to be held to a maximum of about 15 m or as dictated by the unit bay dimensions. Vertical construction joints provided in two successive lifts shall be staggered.

NOTE — If the width of unit bay is more than 15 m, it may be desirable to lay the concrete in the whole width at a stretch and limiting the length of the strip in transverse directions so that the volume of concrete to be laid at a stretch is not excessive.

6.2.1.1 The first horizontal joints in large, heavy slabs at foundation level shall usually be kept as 0.75 m to 1 m and then at 1.5 m. All lifts shall be placed at minimum 3 days intervals but 5 days shall be preferred for 1.5 m lifts.

6.2.1.2 Construction joints for the draft tube liner shall be so located as to allow for sufficient working space between the liner and the concrete already placed.

6.2.1.3 Construction joint shall be provided in draft tube piers near their junction with the draft tube roof slab (below the fillets, if provided).

6.2.2 *Contraction Joints*

Since the type of joint introduces a structural discontinuity in a member, their location is primarily dependent upon the type of structural design that is to be adopted.

NOTE — The spacing of these joints does not normally exceed 35 m except in power stations with overall length of about 45 m.

6.2.3 *Expansion Joints*

Expansion joints are normally not required in the sub-structure because this portion remains surrounded by water and temperature rise is not likely. Sometimes expansion joints are provided between the draft tube portion of the two adjacent units protruding outside the power station building and also in the sub-structure between adjacent units if the construction period is large.

6.2.4 *Separation Joints*

In case the power station structure is located continuous with the dam a separation joint shall be provided between the dam and the power house structure. It may also be provided between machine hall and service bay/auxilliary block.

6.3 Location of Joints in Intermediate Structure

6.3.1 *Construction Joints*

Horizontal and vertical construction joints are generally provided as dictated by the sequence of construction as against the erection schedule of the machine.

6.3.1.1 In case of concrete spiral casing, the walls of spiral casing are thin members as compared to the mass concrete lying just below it. So this concrete may be subjected to considerable horizontal stresses due to restraint from below. To avoid this following practices are recommended:

a) First pour of concrete in spiral casing walls shall be placed in five sections, three consisting of the central portion of the downstream wall and the upstream half of the end walls are placed first. Then, approximately after lapse of one week, the heavy corner sections shall be placed. Simillarly, the roof shall be divided in 8 pier shaped segments and four in opposite pairs shall be placed simultaneously one week after completion of work. After one more week the four intervening segments shall be placed simultaneously.

b) Concrete for the entire section shall be placed in lifts of about 60 to 75 cm and horizontal construction joints shall be provided between each lift.

6.3.1.2 In case of steel spiral casings the concreting shall be done in a manner similar to that specified in **6.3.1.1** except that additional precautions shall be taken to avoid distortion of embedded parts and shrinkage of concrete away from bearing surfaces. Concreting in the inaccessible portions under the spiral casing shall be done either through J-shaped pipes extending under the spiral casing or through openings left in the speed ring.

6.3.2 *Contraction Joints*

These shall be provided at places where the structural discontinuity is required to relieve tensile stresses due to shrinkage. The location of such joints will be decided by the designers.

6.3.3 *Expansion Joints*

The vertical contraction or expansion joints if provided in the sub-structure shall be continued in the intermediate structure as expansion joints. In case no expansion or contraction joints are provided in the sub-structure between two unit bays or unit bay and service bay, expansion joints may be provided in the intermediate structure at the junction of two adjacent unit bays or unit bay and service bay.

6.3.4 *Separation Joints*

Separation joints may be provided between the generator support and the floors lying above the turbine floor so that the vibrations of the machines are not transmitted to these floors. These joints shall also be provided at those places where the two members are to be kept structurally separate.

6.3.5 *Control Joints*

In case of concrete barrel supporting the generator, circumferential cracks normally develop and in order to check that these cracks do not develop in a haphazard manner, circular horizontal control joints may be provided to restrict their location.

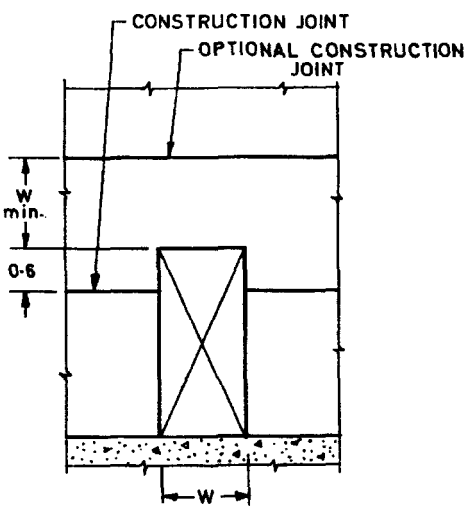
6.4 Location of Joints in Superstructure

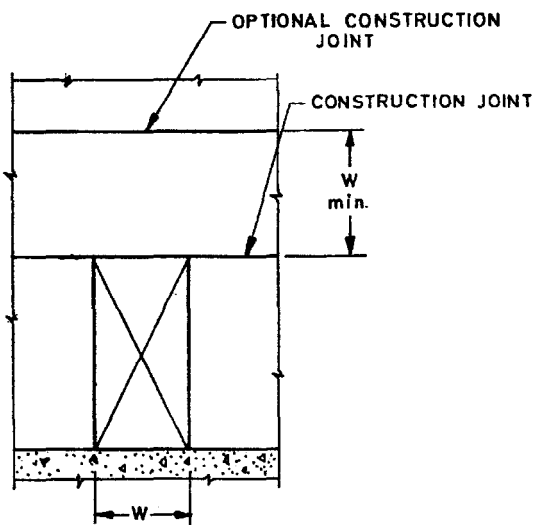
6.4.1 *Construction Joints*

No specific places may be specified in the superstructure where the construction joints shall be provided, however, these are governed by the extent to which continuous concreting may be done.

6.4.1.1 Horizontal joints in walls may be spaced from 1.5 to 3 m depending upon distances between setbacks for seats for floor slabs. Vertical joints may not generally be necessary where walls are intercepted by columns with construction joints in between. In case there are any long continuous concrete walls, vertical construction joints suitably staggered in successive lifts by at least 30 cm shall be provided at interval of 10 to 20 m and appropriate time interval shall be provided between placement of adjacent blocks.

6.4.1.2 Construction joints at openings shall be located as shown in Fig. 2 in order to avoid corner cracks due to settlement of fresh concrete at the sides of wall openings. Where construction joints are not used, placement of wall concrete shall be discontinued for a period of 1 to 2 h or as long as practicable without causing cold joints.





All dimensions in millimetres.

FIG. 2 TYPICAL LOCATION OF CONSTRUCTION JOINTS AT OPENINGS

6.4.2 *Contraction Joints*

The contraction joint shall be provided at places where structural discontinuity is desired depending upon the type of arrangement of different parts and their design. These joints shall be effectively water proofed so that rain water does not seep through them.

6.4.3 *Expansion Joints*

Generally, it is convenient to extend the expansion joint of the intermediate structure right up to the top.

6.4.4 *Control Joints*

Control joints shall be provided at the openings in the walls for doors and windows.

7 DETAILS OF JOINTS

7.1 Construction Joints

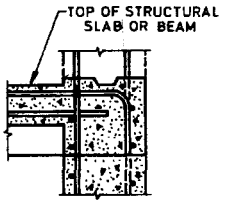
In construction joint it is necessary that there shall be bond between the old and the fresh concrete. Proper arrangements shall, therefore, be made to make the bond effective (*see also* **6.2.1**).

7.1.1 The bond may be made effective by clearing the old surface either by air water jet for green cutting or by sand blasting if the lower layer of concrete is more than three days old. A 5 mm thick layer of cement mortar (of the same mix as for concrete) shall be then placed over the surface before laying fresh concrete.

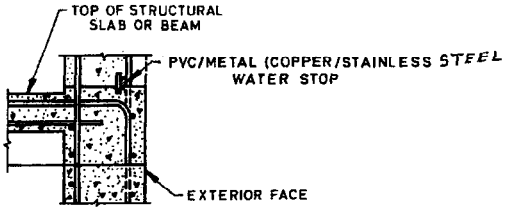
7.1.2 For horizontal construction joints no dowels are necessary for proper bond, if the surface is properly prepared, in accordance with **7.1.1**, whether it is plain or reinforced concrete. If the structure is liable to hydrostatic forces then the dowels shall be provided to carry the full hydrostatic pressure minus the weight of concrete on top providing proper bond lengths in each lift. Typical keys as shown in Fig. 3 shall be provided where these have to resist heavy shears caused by lateral loads. In case of vertical joints, vertical gaps are possible on account of shrinkage of concrete and it is recommended that dowels at the rate of 3 to 6 cm^2/m^2 area may be provided. If there is a stress condition in vertical joint, then these dowels shall be designed to carry the whole stress treating the joint as cracked section. However, in case of reinforced concrete, for both horizontal and vertical joints, the reinforcement of the previous placement shall be continued through acting as dowels.

7.2 Contraction Joints

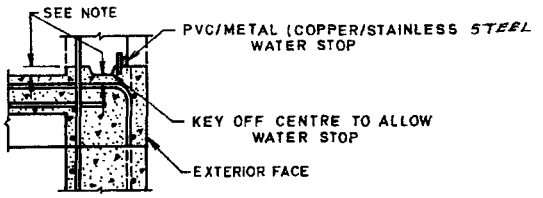
Contraction joint shall introduce structural discontinuity between the structures on which it is provided. This may be done by concreting on one side of the joint first and after the form is removed from the joint face after applying a coat of sealing compound conforming to IS 13143 to prevent adhesion of concrete placed against it.



WITH KEY



WITH WATER STOP



WITH WATER STOP AND KEY

NOTE — Height of slab wall shall be sufficient for bottom of bay or stop to clear slab or beam reinforcement by 25 mm minimum.

FIG. 3 TYPICAL DETAILS OF HORIZONTAL CONSTRUCTION JOINT IN WALLS

7.3 Expansion Joints

In order to provide an expansion joint a space usually 12 to 25 mm shall be left between the concrete joint faces to permit expansion.

Separation of adjoining structures or parts of the same structure is required for structures having different total heights or storey heights and different dynamic characteristics. This is to avoid collusion during an earthquake. If the heights of the adjoining structures are the same having similar dynamic characteristics, the gaps need not be wider than what is required at expansion joints, where the adjoining structures have different total heights of storey heights and where the dynamic characteristics are estimated to be appreciably different, minimum width of separation joint shall conform to IS 4326. Separation joints provided as given above will serve the purpose of expansion joint also.

7.3.1 *Expansion Joint Filler*

The joint filler which is performed material [*see* IS 1838 (Part 1)] may be secured to vertical concrete by nails in the first placed concrete. The joint filler

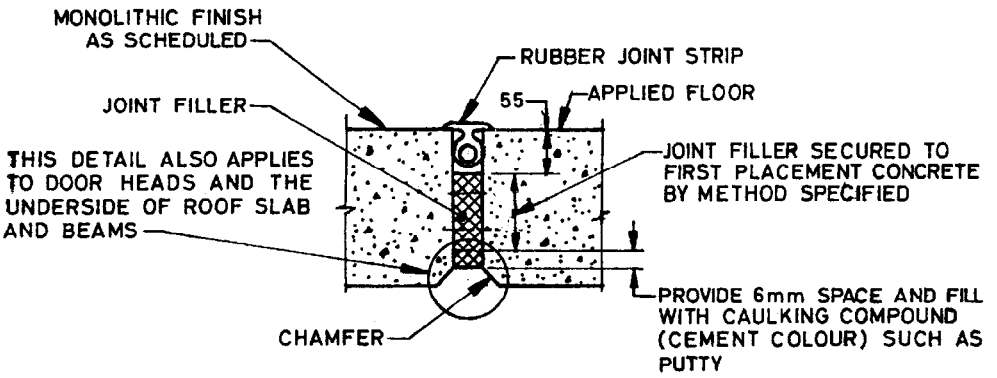
shall be coated on both faces with coal tar pitch conforming to IS 216 or bitumen of suitable grade conforming to IS 73 or IS 702.

7.3.2 *Joint Cover*

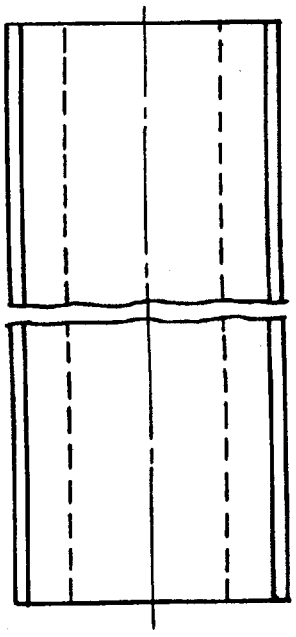
Joint covers shall be used in case of expansion joints in exterior walls or floors to prevent ingress of backfill or silt which might otherwise cause spalling of the concrete edges and would in turn compact and destroy the expansion properties of the material of the joint. For this purpose a PVC protective strip may be used. Typical shapes for such PVC protective strip suitable for different joint widths are shown in Fig. 4. The material for PVC shall conform to Annex A.

It is pressed into place to compensate for movement either at right angles or parallel to the joint. Covers may be omitted on vertical runs above ground or water surface, and also be underside of roofs, floors, slabs and doorheads because of the cost of maintenance and the cost of retaining the cover in place. Fig. 4 gives the details of expansion joint construction at various locations.

PVC joint cover may be replaced by polysulfide based joint seal [*see* IS 12118 (Part 1) and IS 12118 (Part 2)]. These sealants are elastic in nature and adapt themselves to changes in joint dimension. As joints expand and contract the sealants shape changes accordingly but the volume of the sealant remain constant (*see* Fig. 5). It is important that the proper width to depth ratio be specified so that the width of the joint be consistent with the capability of the sealant



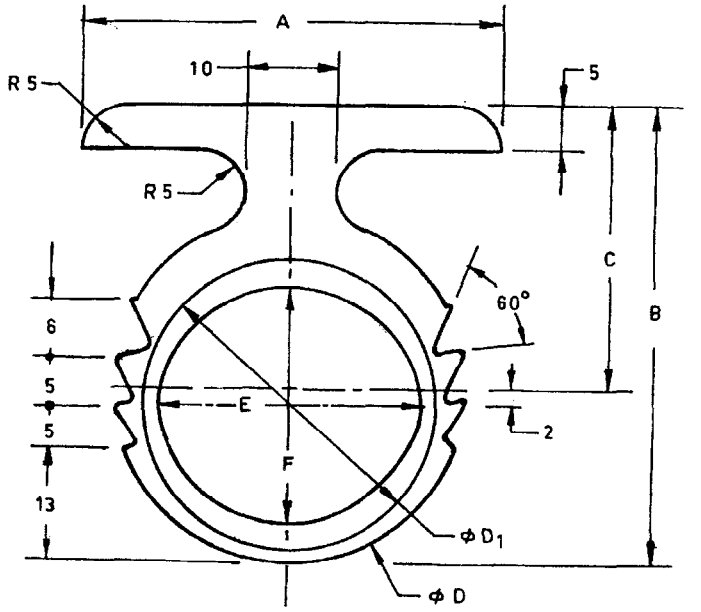
4A Detalis of Fixing Rubber Protective Strip at Expansion Joints



4B Typical Rubber Protective Strip

All dimensions are in millimetres.

FIG. 4 TYPICAL DETAILS AT EXPANSION JOINTS (*Continued*)



Dimensions for Gap	*A*	*B*	*C*	*D*	D_1	*E*	*F*
25 mm to 45 mm	47.8	52	31.6	40	33.5	30	27
20 mm to 25 mm	38.5	44	28	38	32	23	20.5

4C PVC Water Stop
All dimensions in millimetres.

FIG. 4 TYPICAL DETAILS AT EXPANSION JOINTS

to endure the daily and seasonal extension and compression cycles for prolonged periods (*see* below):

Joint Width	*Depth of Sealant in joint*
Up to 12 mm	Same as width
12 to 25 mm	12 mm
Over 25 mm	width/2

7.4 Control Joints

Narrow 'V' grooves 20 mm × 20 mm shall be formed at the location of control joints to weaken the structure and to ensure inconspicuous position for the crack. Exposed grooves shall be filled with suitable plastic caulking compound preferably of cement colour.

7.4.1 Mastic cement for bedded metallic windows conforming to IS 3709 shall be used as plastic caulking compound for control joints of hydroelectric power stations.

7.5 Separation Joints

Its construction features in general are same as that of expansion joints (*see* **7.3**).

7.6 Settlement Joints

The constructional features of a settlement joint are similar to that of an expansion joint (*see* **7.3**). The gap between the concrete surface at a settlement joint shall be usually kept as 40 mm. Details of settlement joint are shown in Fig. 6.

8 WATERPROOFING OF JOINTS

8.1 General

The power station is divided into a number of individual blocks, lifts and pours by various joints and water under pressure may find access to inside of power house through these joints. Therefore, proper

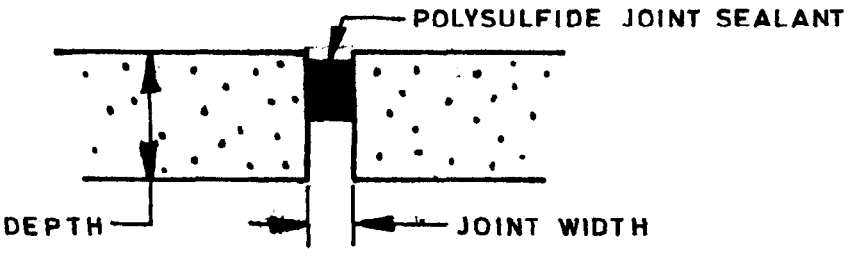
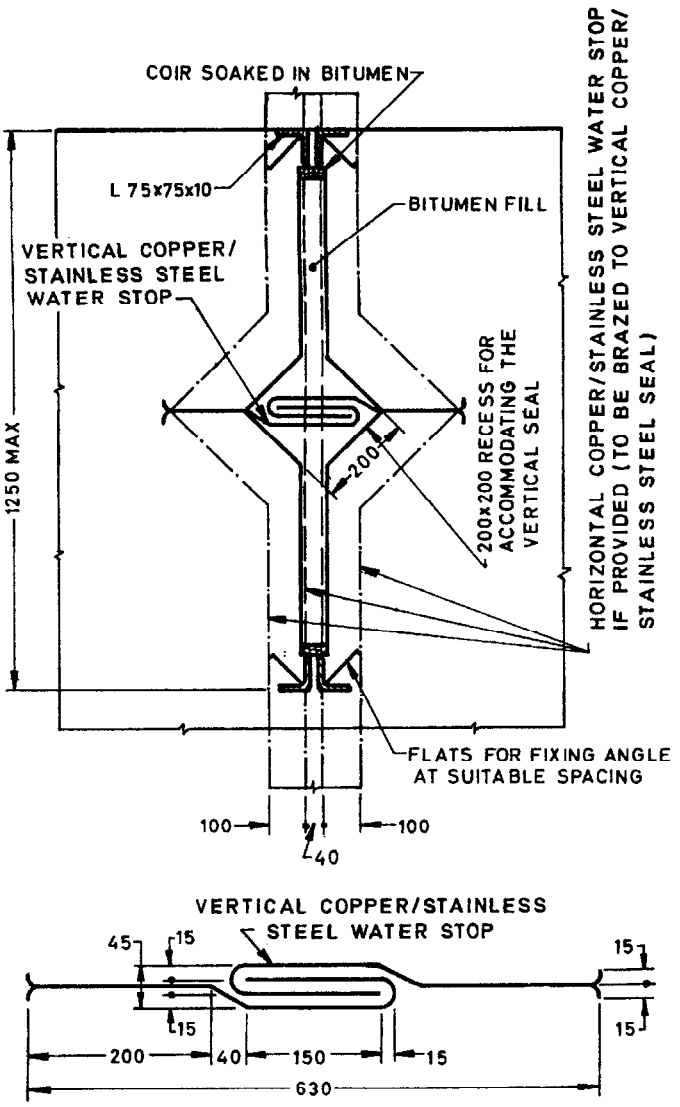


FIG. 5 SEALING WITH POLYSULFIDE JOINT SEALANT



All dimensions in millimetres.

FIG. 6 TYPICAL DETAILS OF WATERPROOFING OF SETTLEMENT JOINTS

sealing arrangements are necessary to prevent seepage of water through these joints. The waterproofing of different types of joints is given in **8.2** to **8.5**. The use of PVC water stops is described in Annex A.

8.2 Waterproofing of Construction Joints

8.2.1 *Horizontal Construction Joints*

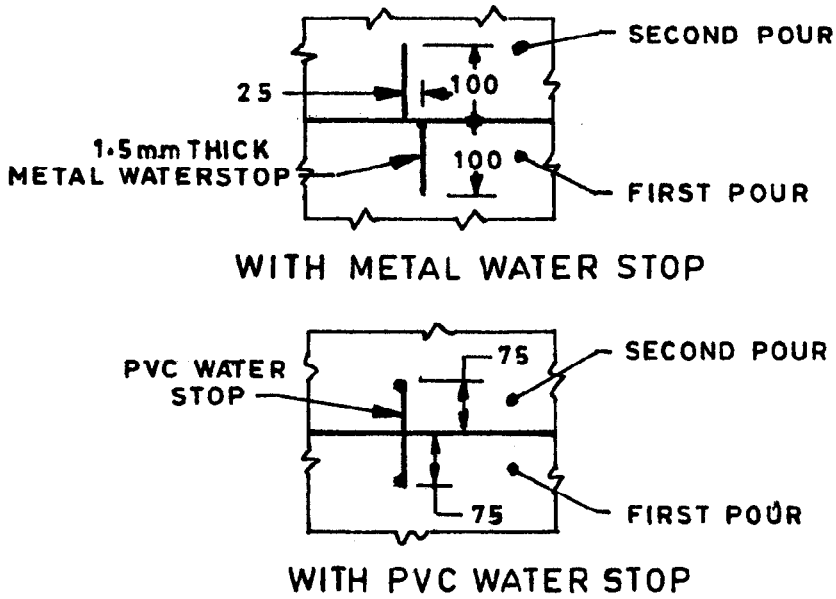
Although horizontal joints if thoroughly cleaned and roughened, are tight, these shall be waterproofed unless the path of water is about 5 m or more. All horizontal joints which are directly connected with water shall be waterproofed. Horizontal joints which are not waterproofed otherwise shall be waterproofed for a distance of about 2 m on each side of the spot where these are crossed by water stop in vertical joints. The details of PVC metal water stops in horizontal joints are shown in Fig. 7.

8.2.2 *Vertical Construction Joints*

Vertical construction joints in contact with water especially those under hydrostatic pressure need effective sealing because of their tendency to open up as concrete shrinks. All joints leading to the interior of concrete spiral casings, intersecting unsealed horizontal joints and other water passages directly shall be waterproofed. The details and method of fixing PVC metal water stops in construction joints are similar as shown in Fig. 7.

8.3 Waterproofing of Contraction Joints

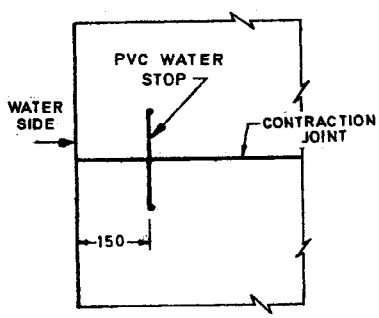
Contraction joints may open up due to shrinkage of concrete hence the PVC water stops provided shall have suitable flexibility.



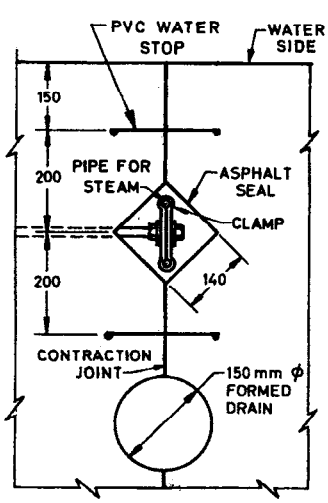
All dimensions in millimetres.

FIG. 7 TYPICAL DETAILS OF WATERPROOFING OF CONSTRUCTION JOINT

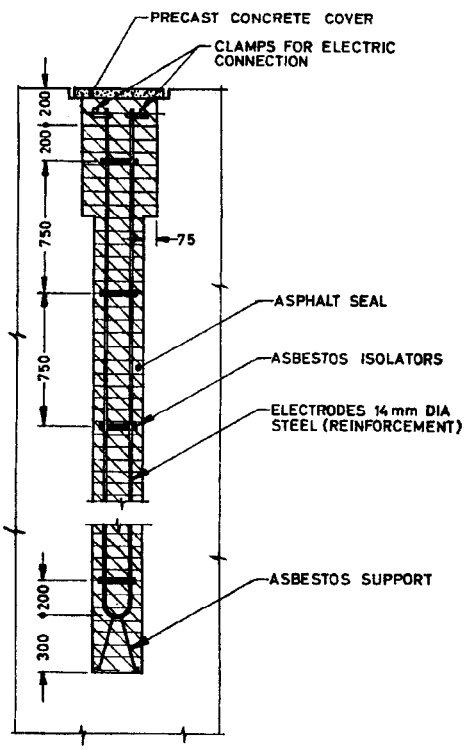
In places which are subject to low or in frequent floods, sealing of contraction joints shall be done by single PVC water stops as shown in Fig. 8A.



8A Single Water Stop



8B Double Water Stop with Asphalt Seal



8C Alternative Heating Arrangement for Asphalt Seal (Electrical)

NOTES

1 The distance between the centre line of the formed drain and the inner water stop shall be a minimum of 225 mm.

2 Heating in the asphalt seal may be done either by steam or by electricity. The arrangement for electrical heating is shown in Fig. 8C.

All dimensions in millimetres.

FIG. 8 TYPICAL DETAILS OF WATERPROOFING OF CONTRACTION JOINTS

8.3.1 In contraction joints which have to sustain high heads two PVC water stops with asphalt seals as shown in Fig. 8 B shall be used. In the horizontal run of the asphalt seals the leading points on the floors shall be so chosen as to ensure effective filling of asphalt and circulation of steam for heating.

NOTE — Where free water is not expected asphalt seal may not be provided.

8.3.2 The asphalt seal as shown in Fig. 8B shall be filled with hot bitumen (*see* **5.3**) during construction to ensure dense filling. Heating may be accomplished either electrically (*see* Fig. 8C) or by steam pipes which shall be left in place and may be used for reheating if leak develops at a later stage. Bleeding arrangement shall be provided for steam pipes at suitable locations. Formed drain may be provided at inner face; the distance between the centre line of the formed drain and the inner water stop shall be minimum of 225 mm.

8.4 Waterproofing of Expansion Joints

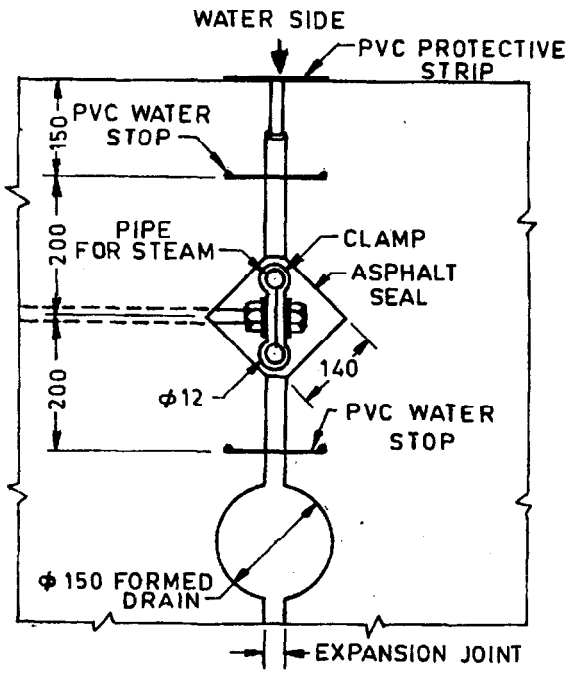
In expansion joints where necessary, waterproofing shall be done by use of PVC water stops with asphalt seal (Fig. 9 A). These water stops provide for movement in horizontal direction. Two water stops shall be installed one on each side of diamond shaped hole which is filled with asphalt or bituminous material as an additional seal against possible leak in the water stops (*see also* **8.3.1**). In expansion joints, formed drains shall be provided on both upstream and downstream sides of the power house up to the highest water level. The distance between the centre line of the formed drain and the inner water stop shall be a minimum of 225 mm.

8.4.1 The waterproofing of expansion joint not subjected to water pressure shall be done by providing one PVC or metal seal (*see* Fig. 9B).

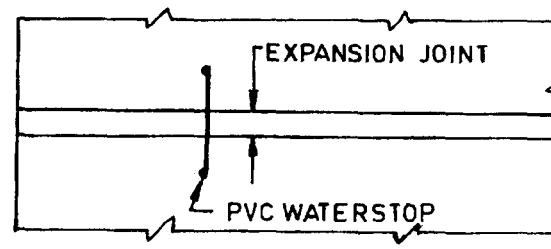
NOTE — The use of PVC water stops is necessary where movement in more than one direction such as expansion and contractions horizontally and unequal settlement vertically, is expected.

8.5 Waterproofing of Settlement Joints

The waterproofing of these joints shall be such that it shall withstand differential settlement of the two members between which it is provided. Waterproofing in horizontal direction of a settlement joint, where necessary, may be done by the provision of PVC water stops similar as shown in Fig. 8B or V-type metal water stop an asphalt seal and a formed drain may also be provided in addition if warranted by high head. For waterproofing in vertical direction of a settlement joint, arrangement shown in Fig. 6 may be used. A formed drain at the inner face of joint may also be provided if situation warrants and permits.



9A Joint Subjected to Water Pressure



9B Joint not Subjected to Water Pressure

NOTES

1 The distance between the centre line of the formed drain and the inner water stop shall be a minimum of 225 mm.

2 Heating in the asphalt seal may be done either by steam or by electricity. The arrangement for electrical heating is shown in Fig. 8C.

All dimensions in millimetres.

FIG. 9 TYPICAL DETAILS OF WATERPROOFING OF EXPANSION JOINTS

ANNEX A

(*Clauses* 7.3.2 *and* 8.1)

WATER STOPS FOR WATERPROOFING OF JOINTS

A-1 PVC water stops are basically of two types, the integral type which is embedded within the concrete and the surface type as the name implies, is embedded in the cover region of the concrete. The material for PVC water stops shall conform to as given in **5** of IS 12200.

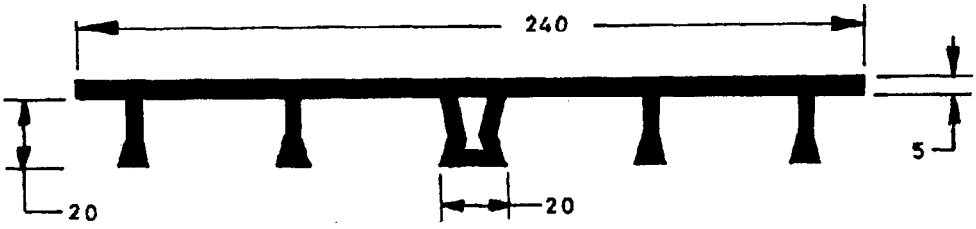
A-2 SURFACE TYPE WATER STOPS

Where the steel reinforcement within the body of the concrete interferes with the placement of the water stop, PVC surface type water stops as shown in Fig. 10 are used to an advantage as they are embedded in the cover region of the concrete as shown in Fig. 11.

A-3 INTEGRAL TYPE WATER STOPS

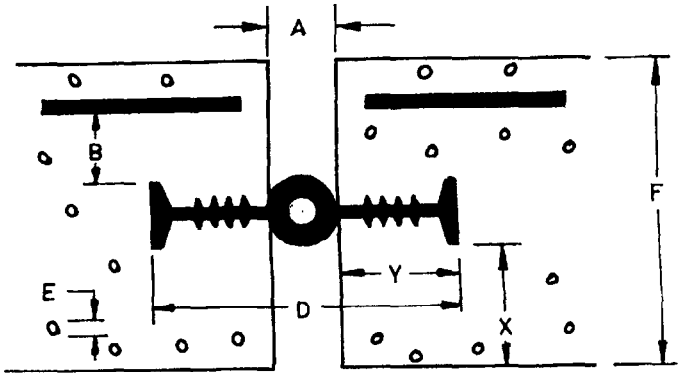
A-3.1 This type of water stops is suitable where reinforcement in the concrete does not interfere with the placement of the water stops.

A-3.1.1 *For Expansion and Contraction Joint Water stops (see Fig 12A and 12B)*



All dimensions in millimetres.

FIG. 10 TYPICAL PVC WATER STOPS

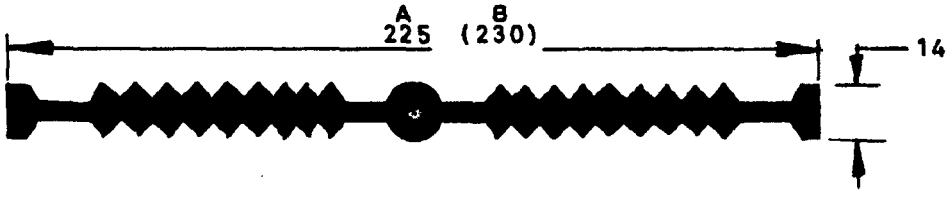


1. D not greater than *F*
2. *D* = Approximately (6 × *E*) + *A*
3. *X* should be equal to or more than *Y*
4. *B* should be equal to or more than 2 × *E*

E—Largest aggregate size

F—Reinforcement bar

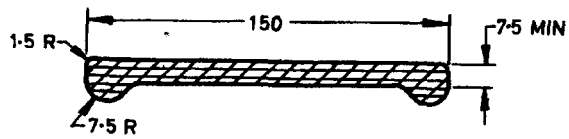
FIG. 11 SELECTION OF WIDTH OF WATER STOP



All dimensions in millimetres.

FIG. 12 TYPICAL PVC WATER STOPS

A-3.1.2 For construction joint water stops (*see* Fig. 13 and Fig. 14.



All dimensions in millimetres.

FIG. 13 TYPICAL PVC WATER STOPS

A-4 SELECTION OF TYPE AND SIZE OF WATER STOPS

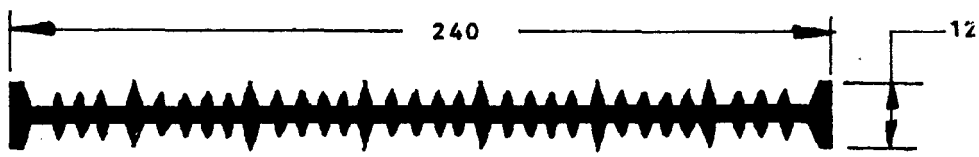
A-4.1 The selection of type and size of water stops depends on the following considerations:

i) *Extent of hydrostatic pressure* — This will determine basically the thickness of water stops.

ii) *Type of joint (that is movement expected in the particular type of joint like expansion, contraction, settlement, etc)* — This will determine the shape and width of water stop. Extra watertightness is provided by the flat corrugation/ribs on water stop. However these corrugations have the effect on reducing the expansion ability of water stop. The central bulb is provided in water stop to take care of deformation in conditions of movements in joints. Dumb bell water stop provide good expansionability.

iii) *Convenience of placement* — In situations where the placement of water stops is difficult due to interference of reinforcement or for reasons of placement of concreting externally placed (surface) water stops are used.

Besides the position of reinforcements the aggregate size and thickness of concrete structures have bearing on selection of suitable type of water stop. Fig. 15 shows how to select the width of water stop in relation to the position of reinforcement the aggregate size and the concrete thickness of structural member.



All dimensions in millimetres.

FIG. 14 TYPICAL PVC WATER STOPS

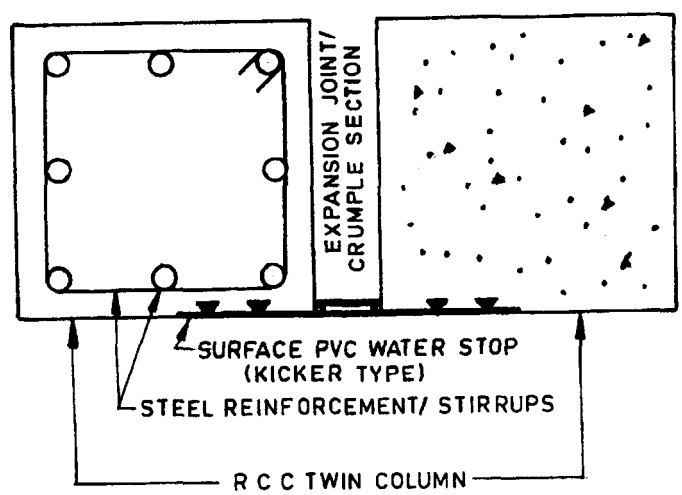


FIG. 15 TYPICAL SECTION TROUGH RCC COLUMNS AT EXPANSION JOINTS/CRUMPLE SECTION

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